DEPARTMENT OF COMMERCE AND LABOR
BUREAU OF STANDARDS

THE INTERNATIONAL

METRIC SYSTEM

OF

WEIGHTS AND MEASURES

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THE INTERNATIONAL METRIC SYSTEM OF WEIGHTS AND MEASURES.

INTRODUCTION.

The following was prepared to answer some of the more simple questions addressed to the Bureau of Standards in regard to the metric system of weights and measures and its use.

The essential features of the system were embodied in a report made to the French National Assembly by the Academy of Sciences in 1791. A number of other nations were invited to cooperate with France in establishing the new system, and Holland, Denmark, Switzerland, Spain, and several minor States were represented on an international commission which met in Paris in 1799 to accept the metric standards constructed under the direction of the French Institute.

Although the metric system very soon attracted the favorable attention of other nations, it was not until forty years later that its use became general in France. Since 1840, however, its use has rapidly spread until at the present time it is either obligatory or permissive in every civilized country in the world. Its use was made "lawful throughout the United States" by act of Congress in 1866, and at the same time provision was made to supply every State in the Union with a set of metric weights and measures.

No organized effort had been made up to this time to supply the different countries with authentic copies of the metric prototypes which were preserved in the archives of France. In order to meet the demand for accurate standards whose relation to one another would be known with the highest precision, metric conventions were held in Paris in 1870 and 1872, which were attended by official delegates from about thirty countries. At these conferences committees were appointed to investigate the best form and material

for the proposed new standards. In 1875 a treaty was signed at Paris by seventeen of the principal nations of the world, the United States being among the number, which provided for the permanent organization of an International Bureau of Weights and Measures under the direction of an International Committee. The most important work of the International Committee was to provide for the construction of a sufficient number of platinum-iridium meters and kilograms to meet the demand of the interested nations. The comparison of all these standards with one another and with the original meter and kilogram was made at the International Bureau which had been established near Paris on neutral territory ceded to the International Committee by the French Government.

This work was completed in 1889, and after selecting a certain meter and a certain kilogram as the international prototypes, the others were distributed by lot to the different countries. The international meter and kilogram[a] have values identical with the original meter and kilogram, are preserved in a special underground vault at the International Bureau, and are accessible only to the International Committee. The United States secured two meters and two kilograms, which are now preserved at the Bureau of Standards at Washington and serve as the fundamental standards of length and mass of the United States. It is the plan of the International Committee to intercompare all the national meters and kilograms with the international prototypes at regular intervals or whenever considered necessary.

At the present time the International Bureau of Weights and Measures is supported jointly by the following countries: The United States, Great Britain, Germany, Russia, France, Austria-Hungary, Belgium, Argentine Confederation, Spain, Italy, Mexico, Peru, Portugal, Roumania, Servia, Sweden, Norway, Switzerland, Venezuela, Japan, and Denmark.

The advantages claimed for the metric system are:

(1) The decimal relation between the units.

(2) The extremely simple relation of the units of length, area, volume, and weight to one another.

(3) The uniform and self-defining names of units.

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[a] The original meter and kilogram "of the Archives" were adopted as standard in 1799.

SYNOPSIS OF THE SYSTEM.

The fundamental unit of the metric system is the METER—the unit of length. From this the units of capacity (LITER) and of weight (GRAM) were derived. All other units are the decimal subdivisions or multiples of these. These three units are simply related; e. g., for all practical purposes one CUBIC DECIMETER equals one LITER and one LITER of water weighs one KILOGRAM. The metric tables are formed by combining the words "METER," "GRAM," and "LITER" with the six numerical prefixes, as in the following tables:

PREFIXES		MEANING			UNITS
milli-	=	*one thousandth*	$\frac{1}{1000}$	.001	**"meter"** *for length,*
centi-	=	*one hundredth*	$\frac{1}{100}$	.01	
deci-	=	*one tenth*	$\frac{1}{10}$	.1	
Unit	=	*one*		1	**"gram"** *for weight or mass,*
deka-	=	*ten*	$\frac{10}{1}$	10	
hecto-	=	*one hundred*	$\frac{100}{1}$	100	**"liter"** *for capacity.*
kilo-	=	*one thousand*	$\frac{1000}{1}$	1000	

UNITS OF LENGTH.

milli-meter	=	.001	**meter.**
centi-meter	=	.01	"
deci-meter	=	.1	"
METER[a]	=	1	"
deka-meter	=	10	"
hecto-meter	=	100	"
kilo-meter	=	1,000	"

Where *miles* are used in England and the United States for measuring distances, the *kilometer* (1,000 meters) is used in metric countries. The kilometer is about 5 furlongs. There are about 1,600 meters in a statute mile, 20 meters in a chain, and 5 meters in a rod.

[a] One meter equals 39.37 inches exactly.

The *meter* is used for dry goods, merchandise, engineering construction, building, and other purposes where the *yard* and *foot* are used. The meter is about a tenth longer than the yard.

The *centimeter* and *millimeter* are used instead of the *inch* and its fractions in machine construction and similar work. The centimeter, as its name shows, is the hundredth of a meter. It is used in cabinet work, in expressing sizes of paper, books, and many cases where the inch is used. The centimeter is about two-fifths of an inch and the millimeter about one twenty-fifth of an inch. The millimeter is divided for finer work into tenths, hundredths, and thousandths.

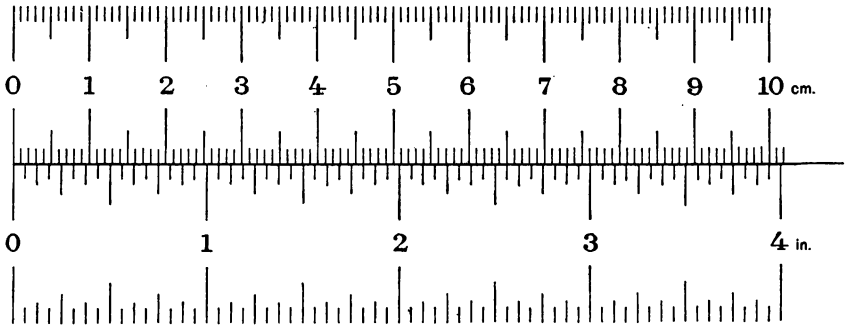

FIG. 1. COMPARISON SCALE: 10 CENTIMETERS AND 4 INCHES. (ACTUAL SIZE.)

If a number of distances in millimeters, meters, and kilometers are to be added, reduction is unnecessary. They are added as dollars, dimes, and cents are now added. For example, "1,050.25 meters" is not read "1 kilometer; 5 dekameters, 2 decimeters, and 5 centimeters," but "one thousand and fifty meters, twenty-five centimeters," just as "$1,050.25" is read "one thousand and fifty dollars. twenty-five cents."

AREA.

The table of areas is formed by squaring the length measures, as in our common system. For land measure 10 meters square is called an "ARE" (meaning "area"). The side of one *are* is about 33 *feet*. The HECTARE is 100 meters square, and, as its name indicates, is 100 ares, or about 2½ acres. An *acre* is about 0.4

hectare. A standard United States *quarter section* contains almost exactly 64 hectares. A *square kilometer* contains 100 hectares.

For smaller measures of surface the *square meter* is used. The square meter is about 20 per cent larger than the *square yard.* For still smaller surfaces the *square centimeter* is used. A *square inch* contains about 6½ square centimeters.

VOLUME.

The cubic measures are the cubes of the linear units. The *cubic meter* (sometimes called the *stère*, meaning "solid") is the unit of

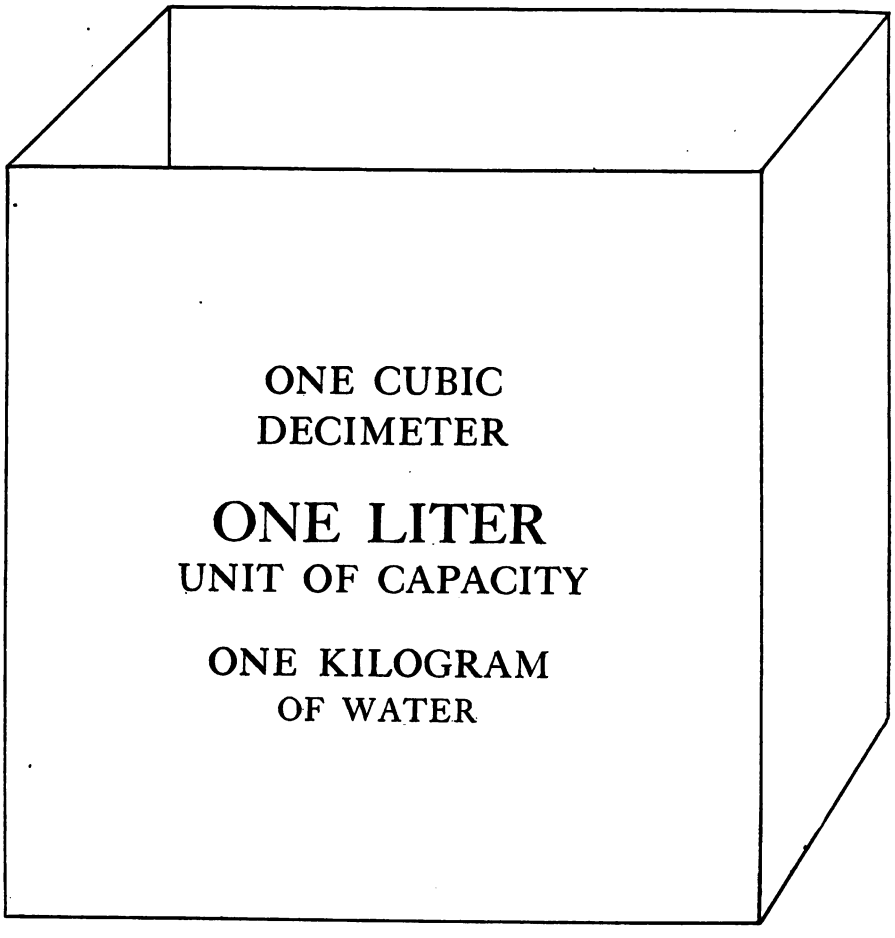

FIG. 2. CUBIC DECIMETER. (ACTUAL SIZE.)

volume. A *cubic meter* of water weighs a *metric ton* and is equal to 1 *kiloliter*. The cubic meter is used in place of the cubic yard and is about 30 per cent larger. This is used for "cuts and fills" in grading land, measuring timber, expressing contents of tanks and reservoirs, flow of rivers, dimensions of stone, tonnage of ships, and other places where the cubic yard and foot are used. The thousandth part of the cubic meter (1 cubic decimeter) is called the LITER. (See table of capacity units.)

For very small volumes the *cubic centimeter* (cc or cm^3) is used. This volume of water weighs a *gram*, which is the unit of weight or mass. There are about 16 cubic centimeters in a cubic inch. The cubic centimeter is the unit of volume used by chemists as well as in pharmacy, medicine, surgery, and other technical work. One thousand cubic centimeters make 1 liter.

UNITS OF CAPACITY.

milli-liter	=	**.001**	**liter**
centi-liter	=	**.01**	"
deci-liter	=	**.1**	"
LITER[a]	=	**1**	"
deka-liter	=	**10**	"
hecto-liter	=	**100**	"
kilo-liter	=	**1,000**	"

The *hectoliter* (100 liters) serves the same purposes as the United States *bushel* (2,150.42 cubic inches), and is equal to about 3 bushels, or a barrel. A *peck* is about 9 liters. The liter is used for measurements commonly given in the *gallon*, the liquid and dry *quarts*, a liter being 5 per cent larger than our liquid quart and 10 per cent smaller than the dry quart. A *liter* of water weighs exactly a *kilogram*, i. e., 1,000 grams. A thousand liters of water weigh 1 metric ton.

UNITS OF WEIGHT (OR MASS).

milli-gram	=	**0.001**	**gram**
centi-gram	=	**.01**	"
deci-gram	=	**.1**	"
GRAM	=	**1**	"
deka-gram	=	**10**	"
hecto-gram	=	**100**	"
kilo-gram[b]	=	**1,000**	"

[a] One liter equals 1.05668 liquid quarts or 0.9081 dry quarts.
[b] One kilogram equals 2.204622 avoirdupois pounds.

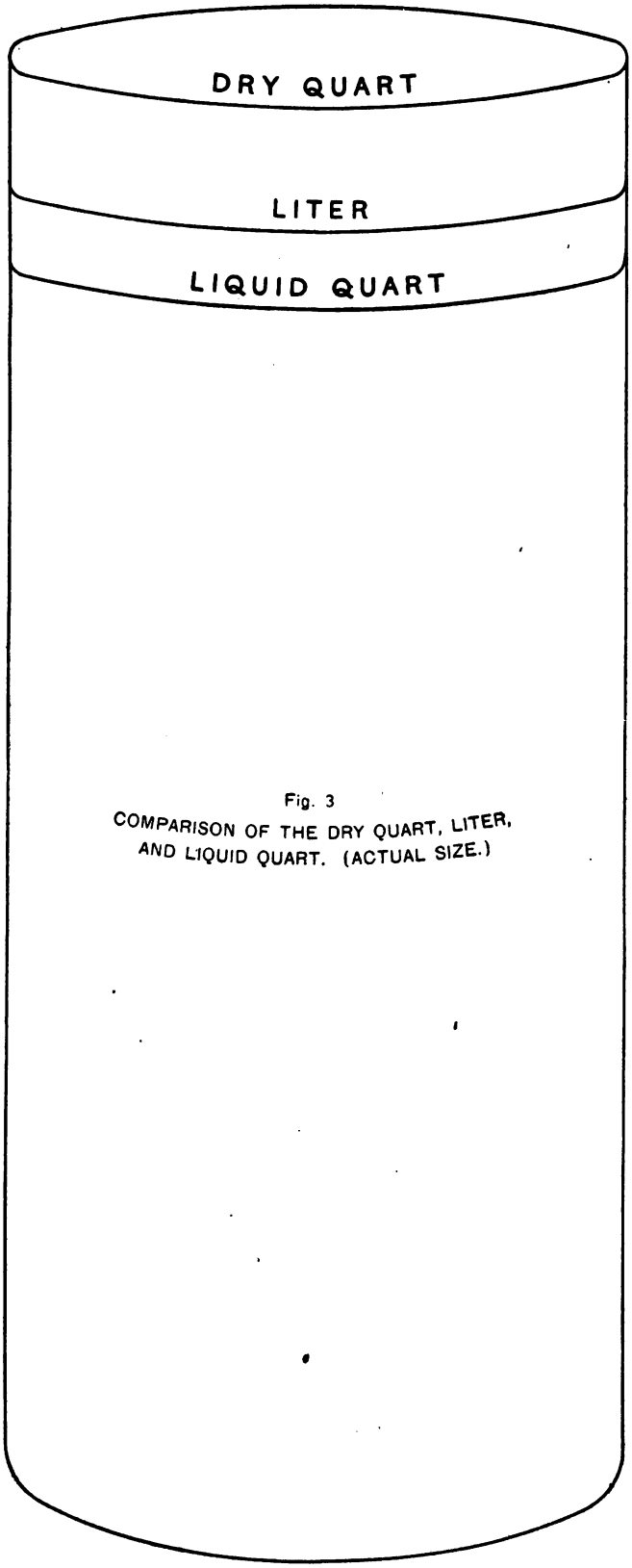

Fig. 3
COMPARISON OF THE DRY QUART, LITER, AND LIQUID QUART. (ACTUAL SIZE.)

Measurements commonly expressed in *gross tons* or *short tons* are stated in *metric tons* (1,000 kilograms). The metric ton comes between our long and short tons and serves the purpose of both.

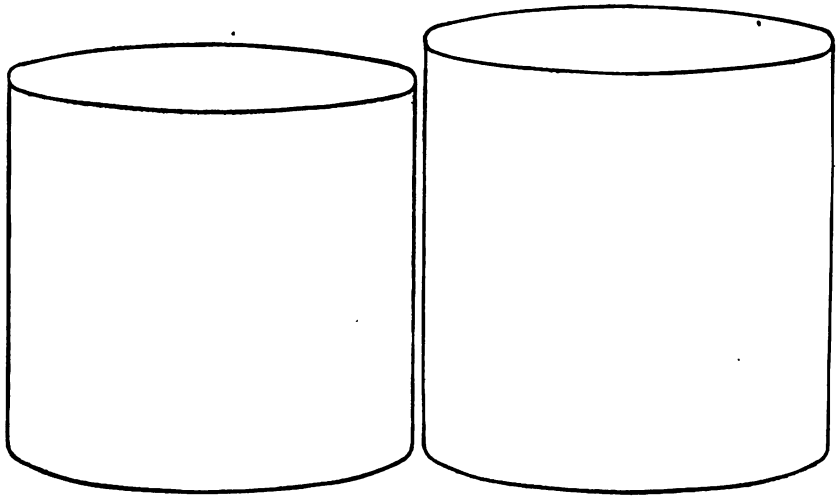

FIG. 4. RELATIVE SIZE OF 2-POUND AND 1-KILOGRAM (BRASS) WEIGHTS. (ACTUAL SIZE.)

The *kilogram* and "half kilo" serve for everyday trade, the latter being 10 per cent larger than the pound. The kilogram is approximately 2.2 pounds. The *gram* and its multiples and divisions are

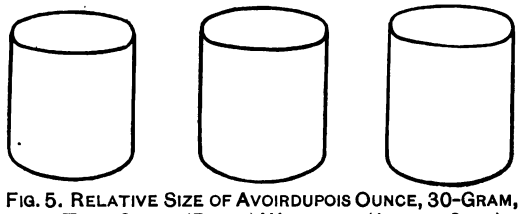

FIG. 5. RELATIVE SIZE OF AVOIRDUPOIS OUNCE, 30-GRAM, AND TROY OUNCE (BRASS) WEIGHTS. (ACTUAL SIZE.)

FIG. 6. RELATIVE SIZE OF GRAM AND SCRUPLE (BRASS) WEIGHTS. (ACTUAL SIZE.)

used for the same purposes as ounces, pennyweights, drams, scruples, and grains. For foreign postage, 30 grams is the legal equivalent of the avoirdupois ounce.

STATUS OF THE INTERNATIONAL METRIC SYSTEM IN THE UNITED STATES.

"The Congress shall have power to * * * fix the standard of weights and measures." (Constitution of the United States.)

THE METRIC SYSTEM LEGALIZED.

"It shall be lawful throughout the United States of America to employ the weights and measures of the metric system." (Revised Statutes of the United States, sec. 3569, 1866.)

THE METRIC STANDARDS ADOPTED AS FUNDAMENTAL.

"The office of weights and measures * * * will in the future regard the international prototype meter and kilogram as fundamental standards, in accordance with the act of July 28, 1866." (Order approved by the Secretary of the Treasury, April 5, 1893.)

FOREIGN POSTAL RATES BASED ON METRIC WEIGHTS.

"The Postmaster-General shall furnish to the post-offices exchanging mails with foreign countries, and to such other offices as he may deem expedient, postal balances denominated in grams of the metric system, fifteen grams of which shall be the equivalent for postal purposes, of one-half ounce avoirdupois, and so on in progression." (Revised Statutes of the United States, sec. 3880.)

METRIC WEIGHTS USED IN THE COINAGE.

"The weight of the half-dollar shall be twelve grams and one-half of a gram; the quarter-dollar and the dime shall be, respectively, one-half and one-fifth of the weight of said half-dollar." (Revised Statutes of the United States, sec. 3513.)

CONGRESS PROVIDES METRIC STANDARDS FOR THE STATES OF THE UNION.

"*Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of the Treasury be, and he is hereby, authorized and directed to furnish to each State, to be delivered to the governor thereof, one set of the

standard weights and measures of the metric system for the use of the States, respectively." (Joint resolution of Congress approved July 27, 1866.)

UNITED STATES JOINS IN ESTABLISHING INTERNATIONAL BUREAU.

"The high contracting parties engage to establish and maintain, at their common expense, a scientific and permanent international bureau[a] of weights and measures, the location of which shall be at Paris." (Extract from convention of 1875, signed for the United States by the United States ambassador to France.)

CONGRESS ADOPTS THE METRIC UNITS FOR ELECTRICAL MEASURES.

It was enacted by the Senate and House of Representatives that the international electrical units based on the metric system "shall be the legal units of electrical measure in the United States." (Revised Statutes of the United States, Supplement, vol. 2, chap. 131, 1894.)

METRIC SYSTEM REQUIRED IN THE MEDICAL WORK OF THE NAVY DEPARTMENT.

"The metric system of weights and measures shall hereafter be employed in the Medical Department of the Navy." (Order approved by the Secretary of the Navy, April 15, 1878.)

METRIC SYSTEM REQUIRED IN MEDICAL WORK OF WAR DEPARTMENT.

"All requisitions, invoices, receipts and returns, pertaining to medical supplies will be in accordance with the metric system of weights and measures. After the 30th day of June, 1894, the use of this system in writing official prescriptions is desired; on and after the 1st day of January, 1895, such use is hereby ordered." (Order approved by Secretary of War April 13, 1894.)

METRIC SYSTEM MADE OBLIGATORY IN PORTO RICO.

"1. The use of the metrical system of weights and measures and its nomenclature are obligatory.

"2. Its use is enforced in all transactions, sales, contracts. * * *

"3. Wholesale and retail mercantile establishments shall sell their goods to the public conformably to the metric system." (Proclamation of military governor, March 18, 1899, Department of Porto Rico.)

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[a] This bureau has the custody of the international standards of the metric system, to which all metric prototypes of the world are referred for verification. It was established and is maintained jointly by all the principal governments of the world.

METRIC SYSTEM MADE THE LEGAL SYSTEM IN THE PHILIPPINE ISLANDS.

"The metrical system of weights and measures as authorized by sections 3569 and 3570 of the Revised Statutes of the United States and at present in use in the Philippine Islands shall be continued." (Act No. 230, September 17, 1901, sec. 9, Philippine Tariff.)

METRIC SYSTEM REQUIRED IN UNITED STATES PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

"Officers shall, for all official, medical, and pharmacal purposes, make use of the metric system of weights and measures. In expressing quantities by weight the terms of 'gram' and 'centigram,' and in expressing quantity by measure the term 'cubic-centimeter,' only shall be employed." (Regulation promulgated by the President November 21, 1902.)

COMPARISON OF METRIC AND CUSTOMARY UNITS FROM 1 TO 10.

LENGTH.

Inches.	Millimeters.	Inches.	Centimeters.	Feet.	Meters.	U. S. yards.	Meters.	U. S. miles.	Kilometers.
0.03937 =	1	0.3937 =	1	1	= 0.304801	1	= 0.914402	0.62137 =	1
0.07874 =	2	0.7874 =	2	2	= 0.609601	1.093611 =	1	1	= 1.60935
0.11811 =	3	1	= 2.54001	3	= 0.914402	2	= 1.828804	1.24274 =	2
0.15748 =	4	1.1811 =	3	3.28083 =	1	2.187222 =	2	1.86411 =	3
0.19685 =	5	1.5748 =	4	4	= 1.219202	3	= 2.743205	2	= 3.21869
0.23622 =	6	1.9685 =	5	5	= 1.524003	3.280833 =	3	2.48548 =	4
0.27559 =	7	2	= 5.08001	6	= 1.828804	4	= 3.657607	3	= 4.82804
0.31496 =	8	2.3622 =	6	6.56167 =	2	4.374444 =	4	3.10685 =	5
0.35433 =	9	2.7559 =	7	7	= 2.133604	5	= 4.572009	3.72822 =	6
1	= 25.4001	3	= 7.62002	8	= 2.438405	5.468056 =	5	4	= 6.43739
2	= 50.8001	3.1496 =	8	9	= 2.743205	6	= 5.486411	4.34959 =	7
3	= 76.2002	3.5433 =	9	9.84250 =	3	6.561667 =	6	4.97096 =	8
4	= 101.6002	4	= 10.16002	13.12333 =	4	7	= 6.400813	5	= 8.04674
5	= 127.0003	5	= 12.70003	16.40417 =	5	7.655278 =	7	5.59233 =	9
6	= 152.4003	6	= 15.24003	19.68500 =	6	8	= 7.315215	6	= 9.65608
7	= 177.8004	7	= 17.78004	22.96583 =	7	8.748889 =	8	7	= 11.26543
8	= 203.2004	8	= 20.32004	26.24667 =	8	9	= 8.229616	8	= 12.87478
9	= 228.6005	9	= 22.86005	29.52750 =	9	9.842500 =	9	9	= 14.48412

AREA.

Square inches.	Square millimeters.	Square inches.	Square centimeters.	Square feet.	Square meters.	Square yards.	Square meters.	Square miles.	Square kilometers.
0.00155 =	1	0.1550 =	1	1	= 0.09290	1	= 0.8361	0.3861 =	1
0.00310 =	2	0.3100 =	2	2	= 0.18581	1.1960 =	1	0.7722 =	2
0.00465 =	3	0.4650 =	3	3	= 0.27871	2	= 1.6723	1	= 2.5900
0.00620 =	4	0.6200 =	4	4	= 0.37161	2.3920 =	2	1.1583 =	3
0.00775 =	5	0.7750 =	5	5	= 0.46452	3	= 2.5084	1.5444 =	4
0.00930 =	6	0.9300 =	6	6	= 0.55742	3.5880 =	3	1.9305 =	5
0.01085 =	7	1	= 6.452	7	= 0.65032	4	3.3445	2	= 5.1800
0.01240 =	8	1.0850 =	7	8	= 0.74323	4.7839 =	4	2.3166 =	6
0.01395 =	9	1.2400 =	8	9	= 0.83613	5	= 4.1807	2.7027 =	7
1	= 645.16	1.3950 =	9	10.764 =	1	5.9799 =	5	3	= 7.7700
2	= 1,290.33	2	= 12.903	21.528 =	2	6	= 5.0168	3.0888 =	8
3	= 1,935.49	3	= 19.355	32.292 =	3	7	= 5.8529	3.4749 =	9
4	= 2,580.65	4	= 25.807	43.055 =	4	7.1759 =	6	4	= 10.3600
5	= 3,225.81	5	= 32.258	53.819 =	5	8	= 6.6890	5	= 12.9500
6	= 3,870.98	6	= 38.710	64.583 =	6	8.3719 =	7	6	= 15.5400
7	= 4,516.14	7	= 45.161	75.347 =	7	9	= 7.5252	7	= 18.1300
8	= 5,161.30	8	= 51.613	86.111 =	8	9.5679 =	8	8	= 20.7200
9	= 5,806.46	9	= 58.065	96.875 =	9	10.7639 =	9	9	= 23.3100

VOLUME.

Cubic inches.	Cubic millimeters.	Cubic inches.	Cubic centimeters.	Cubic feet	Cubic meters.	Cubic yards.	Cubic meters.
0.000061 =	1	0.0610 =	1	1	= 0.02832	1	= 0.7646
0.000122 =	2	0.1220 =	2	2	= 0.05663	1.3079 =	1
0.000183 =	3	0.1831 =	3	3	= 0.08495	2	= 1.5291
0.000244 =	4	0.2441 =	4	4	= 0.11327	2.6159 =	2
0.000305 =	5	0.3051 =	5	5	= 0.14159	3	= 2.2937
0.000366 =	6	0.3661 =	6	6	= 0.16990	3.9238 =	3
0.000427 =	7	0.4272 =	7	7	= 0.19822	4	= 3.0582
0.000488 =	8	0.4882 =	8	8	= 0.22654	5	= 3.8228
0.000549 =	9	0.5492 =	9	9	= 0.25485	5.2318 =	4
1	= 16,387.2	1	= 16.3872	35.314 =	1	6	= 4.5874
2	= 32,774.3	2	= 32.7743	70.629 =	2	6.5397 =	5
3	= 49,161.5	3	= 49.1615	105.943 =	3	7	= 5.3519
4	= 65,548.6	4	= 65.5486	141.258 =	4	7.8477 =	6
5	= 81,935.8	5	= 81.9358	176.572 =	5	8	= 6.1165
6	= 98,323.0	6	= 98.3230	211.887 =	6	9	= 6.8810
7	= 114,710.1	7	= 114.7101	247.201 =	7	9.1556 =	7
8	= 131,097.3	8	= 131.0973	282.516 =	8	10.4635 =	8
9	= 147,484.5	9	= 147.4845	317.830 =	9	11.7715 =	9

AREA—cont'd.

Acres.	Hectares.
1	= 0.4047
2	= 0.8094
2.471 =	1
3	= 1.2141
4	= 1.6187
4.942 =	2
5	= 2.0234
6	= 2.4281
7	= 2.8328
7.413 =	3
8	= 3.2375
9	= 3.6422
9.884 =	4
12.355 =	5
14.826 =	6
17.297 =	7
19.768 =	8
22.239 =	9

COMPARISON OF METRIC AND CUSTOMARY UNITS FROM 1 TO 10—Cont'd.

CAPACITY.

Milliliters. (cc.)	U. S. liquid ounces.	Milliliters. (cc.)	U. S. apothecaries' drams.	U. S. apothecaries' scruples.	Milliliters. (cc.)	U. S. liquid quarts.	Liters.	U. S. liquid gallons.	Liters.
1	= 0.03381	1	= 0.2705	0.8115	= 1	1	= 0.94636	0.26417	= 1
2	= 0.06763	2	= 0.5410	1	= 1.2322	1.05668	= 1	0.52834	= 2
3	= 0.10144	3	= 0.8115	1.6231	= 2	2	= 1.89272	0.79251	= 3
4	= 0.13526	3.6967	= 1	2	= 2.4645	2.11336	= 2	1	= 3.78543
5	= 0.16907	4	= 1.0820	2.4346	= 3	3	= 2.83908	1.05668	= 4
6	= 0.20288	5	= 1.3525	3	= 3.6967	3.17005	= 3	1.32085	= 5
7	= 0.23670	6	= 1.6231	3.2461	= 4	4	= 3.78543	1.58502	= 6
8	= 0.27051	7	= 1.8936	4	= 4.9290	4.22673	= 4	1.84919	= 7
9	= 0.30432	7.3934	= 2	4.0577	= 5	5	= 4.73179	2	= 7.57087
29.574	= 1	8	= 2.1641	4.8692	= 6	5.28341	= 5	2.11336	= 8
59.147	= 2	9	= 2.4346	5	= 6.1612	6	= 5.67815	2.37753	= 9
88.721	= 3	11.0901	= 3	5.6807	= 7	6.34009	= 6	3	= 11.35630
118.295	= 4	14.7869	= 4	6	= 7.3934	7	= 6.62451	4	= 15.14174
147.869	= 5	18.4836	= 5	6.4923	= 8	7.39677	= 7	5	= 18.92717
177.442	= 6	22.1803	= 6	7	= 8.6257	8	= 7.57088	6	= 22.71261
207.016	= 7	25.8770	= 7	7.3038	= 9	8.45345	= 8	7	= 26.49804
236.590	= 8	29.5737	= 8	8	= 9.8579	9	= 8.51723	8	= 30.28348
266.163	= 9	33.2704	= 9	9	= 11.0901	9.51014	= 9	9	= 34.06891

U. S. dry quarts.	Liters.	U. S. pecks.	Liters.	Dekaliters.	U. S. pecks.	U. S. bushels.	Hectoliters.	U. S. bushels per acre.	Hectoliters per hectare.
0.9081	= 1	0.11351	= 1	0.8810	= 1	1	= 0.35239	1	= 0.87078
1	= 1.1012	0.22702	= 2	1	= 1.1351	2	= 0.70479	1.14840	= 1
1.8162	= 2	0.34053	= 3	1.7620	= 2	2.83774	= 1	2	= 1.74156
2	= 2.2025	0.45404	= 4	2	= 2.2702	3	= 1.05718	2.29680	= 2
2.7242	= 3	0.56755	= 5	2.6429	= 3	4	= 1.40957	3	= 2.61233
3	= 3.3037	0.68106	= 6	3	= 3.4053	5	= 1.76196	3.44519	= 3
3.6323	= 4	0.79457	= 7	3.5239	= 4	5.67548	= 2	4	= 3.48311
4	= 4.4049	0.90808	= 8	4	= 4.5404	6	= 2.11436	4.59359	= 4
4.5404	= 5	1	= 8.80982	4.4049	= 5	7	= 2.46675	5	= 4.35389
5	= 5.5061	1.02157	= 9	5	= 5.6755	8	= 2.81914	5.74199	= 5
5.4485	= 6	2	= 17.61964	5.2859	= 6	8.51323	= 3	6	= 5.22467
6	= 6.6074	3	= 26.42946	6	= 6.8106	9	= 3.17154	6.89039	= 6
6.3565	= 7	4	= 35.23928	6.1669	= 7	11.35097	= 4	7	= 6.09545
7	= 7.7086	5	= 44.04910	7	= 7.9457	14.18871	= 5	8	= 6.96622
7.2646	= 8	6	= 52.85892	7.0479	= 8	17.02645	= 6	8.03879	= 7
8	= 8.8098	7	= 61.66874	7.9288	= 9	19.86420	= 7	9	= 7.83700
8.1727	= 9	8	= 70.47856	8	= 9.0808	22.70194	= 8	9.18719	= 8
9	= 9.9110	9	= 79.28838	9	= 10.2159	25.53968	= 9	10.33558	= 9

WEIGHT (OR MASS).

Grains.	Grams.	Avoirdupois ounces.	Grams.	Troy ounces.	Grams.	Avoirdupois pounds.	Kilograms.	Troy pounds.	Kilograms.
1	= 0.06480	0.03527	= 1	0.03215	= 1	1	= 0.45359	1	= 0.37324
2	= 0.12960	0.07055	= 2	0.06430	= 2	2	= 0.90718	2	= 0.74648
3	= 0.19440	0.10582	= 3	0.09645	= 3	2.20462	= 1	2.67923	= 1
4	= 0.25920	0.14110	= 4	0.12860	= 4	3	= 1.36078	3	= 1.11973
5	= 0.32399	0.17637	= 5	0.16075	= 5	4	= 1.81437	4	= 1.49297
6	= 0.38879	0.21164	= 6	0.19290	= 6	4.40924	= 2	5	= 1.86621
7	= 0.45359	0.24692	= 7	0.22506	= 7	5	= 2.26796	5.35846	= 2
8	= 0.51839	0.28219	= 8	0.25721	= 8	6	= 2.72155	6	= 2.23945
9	= 0.58319	0.31747	= 9	0.28936	= 9	6.61387	= 3	7	= 2.61269
15.4324	= 1	1	= 28.3495	1	= 31.10348	7	= 3.17515	8	= 2.98593
30.8647	= 2	2	= 56.6991	2	= 62.20696	8	= 3.62874	8.03769	= 3
46.2971	= 3	3	= 85.0486	3	= 93.31044	8.81849	= 4	9	= 3.35918
61.7294	= 4	4	= 113.3981	4	= 124.41392	9	= 4.08233	10.71691	= 4
77.1618	= 5	5	= 141.7476	5	= 155.51740	11.02311	= 5	13.39614	= 5
92.5941	= 6	6	= 170.0972	6	= 186.62088	13.22773	= 6	16.07537	= 6
108.0265	= 7	7	= 198.4467	7	= 217.72437	15.43236	= 7	18.75460	= 7
123.4589	= 8	8	= 226.7962	8	= 248.82785	17.63698	= 8	21.43383	= 8
138.8912	= 9	9	= 255.1457	9	= 279.93133	19.84160	= 9	24.11306	= 9